CHAPTER 1

INTRODUCTION

1.1 Preface

The emphasis of the research project is to design a scavenging system for a newly conceptualized small capacity (500 cc), multi-cylinder, two-stroke engine based on the *Scotch-Yoke* mechanism. The research work on the *Scotch-Yoke* engine concept was attempted by *CMC SYTECH Corp. of Australia* [2] and was proven to have several advantages i.e. small size, perfect balance, reduction of the engine weight compare to the conventional reciprocating engine of a same displacement.

The scavenging process in the two-stroke cycle engine has direct influent on the performance of their combustion processes and remains one of the fundamental important strategies towards improvement of fuel utilization efficiency and the reduction of pollutant.

Several C*FD* simulation analyses have been done to characterize the scavenging process for the port geometry optimization. In addition, an unfired test rig for scavenging system measurement has been developed in conjunction with this research work.

1.2 Objectives

The objectives of the research project are:

i. To design an external scavenging system of a two stroke *Scotch-Yoke* multi-cylinder engine
ii. To develop a scavenging system test rig to optimize the scavenging process.
iii. To reduce fresh charge short-circuiting problem in the two-stroke engine.

1.3 Statement of Problem

Scavenging process is required in two-stroke engines in assuring the appropriateness of combustion. However it will also result in the short-circuiting of fresh charge (flow directly from the engine's transfer to the exhaust port). The short-circuiting phenomenon is responsible for the low fuel economy/efficiency and high-unburned hydrocarbons emission.

1.4 Hypothesis

An external scavenging system is required to retrofit the small capacity multi-cylinder, two-stroke horizontally opposed *Scotch-Yoke* engine to improve its scavenging efficiency and overcome the mixture short-circuiting problem.

1.5 Scope

The scopes of work prescribed are as follows:

i. Literature reviews on the two-stroke engine, scavenging systems and *Scotch-Yoke* engine concept
ii. Design of a scavenging system for the two-stroke *Scotch-Yoke* engine.
iii. *Computational Fluid Dynamic(CFD)* code simulation for the scavenging flow analysis
iv. Development of an unfired scavenging system test rig
v. Validation of the hypotheses

1.6 Methodology

The methodology applied in the implementation of this project was as follows:

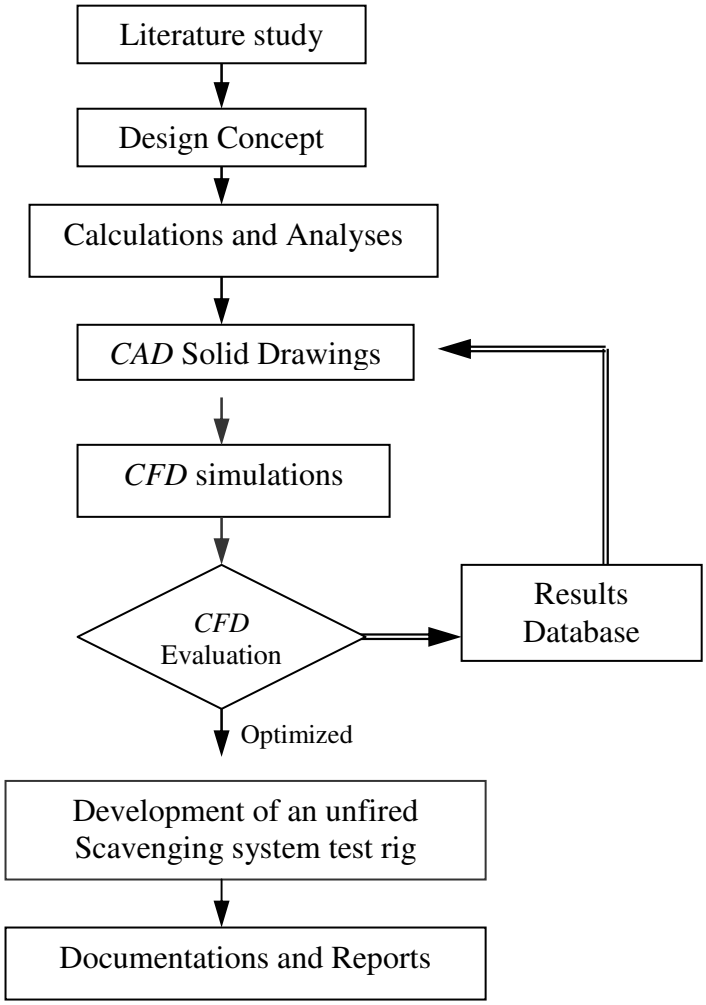

Figure 1.0: Flow chart of project implementation.

1.6.1 Literature Review

The review of recent works is important to provide the understanding of the advancements of two-stroke technologies such as the scavenging systems and *Scotch-Yoke* engine design itself. The previous technical references which are published in the reputable journals such as *Engineering Society for Advancing mobility Land Sea, Air and Space (SAE)* Technical Paper Series, will assist the author in providing new research methods for the scavenging system development. Besides, there are several books and publications on two-stroke engines which will provide first hand knowledge on approaches to engine design and analysis.

1.6.2 Design Concept

With the knowledge obtained from literature study, a design concept of an external scavenging system which is suited to the design of *Scotch-Yoke* mechanism, as well as piston pumps design will be proposed. The loop scavenging arrangement, which is suitable for small capacity gasoline type two-stroke engine, will then be applied for the scavenging port geometry design work.

1.6.3 *CAD* Solid Drawings

It is in the opinion of the author that *Computer-Aided Design* (*CAD*) software, (e.g. *SolidWorks 2004)* is suitable tool to enable engine parts be designed and eventually developed. The specification of the engine parts will be shown in intricate details in finalizing engineering drawings.

1.6.4 *CFD* Simulations

The *Computational Fluid Dynamic (CFD)* simulation work is an important approach to predict the characteristic of the gas exchange processes particularly during the scavenging process. The design of the porting will be improved through the analysis of a series of simulation results.

1.6.5 Development of an Unfired Scavenging System Test Rig

The fabrication works of the unfired scavenging system test rig was done with the assistance of a local engineering company. Prior to this, the engine components detail drawings are prepared for the fabrication works. However, the assembly of the components into a complete unit was not made by the said company, but was made by the author in *UTM*, specifically at the *Automotive Development Center* (ADC).

After the engine model was completely assembled, it was simulated for motion analysis using a specially designed motorized control system. The instrumentations for the scavenging measurement were installed at the engine model. A technique call gas sampling method was applied to evaluate for the engine's overall scavenging system efficiency.

1.7 Gantt Chart

Planning and execution of the project indicates the milestone of the progress of the design and development work within 5 semesters.

Table 1.1: The Gantt chart

Planning and Execution		**Semesters**				
		1	**2**	**3**	**4**	**5**
1. Literature Review	Study on the previous technical paper					
2. Design Concept	Develop the design concept					
3. Calculations and Analyses	1. Engine geometry design					
	2. External pump design					
4. CAD Solid Drawings	*3D* model drawing for the system					
5. CFD simulations	*CFD* code simulation for the design optimization					
6. Fabrication works	Fabrication of the engine model					
7. Test Rig Setting Up	1. Setting up the test rig					
8. Experimental data analysis	Investigation on the Scavenging efficiency					
9. Documentations and Reports	Summary of the Project					

Planned & Execution Extend For Execution